The beneficial effect of using larger particles of limestone has been well established. The interaction of solubility and particle size is less clear. Two experiments were conducted to further understand the relationship. The first study was to determine the response of laying hens to limestones with different solubilities and particle sizes. Hyline W36 hens (1536) were fed one of 12 diets containing either 3.5% or 4.0% Ca. Calcium was supplied by using either a limestone with a low-solubility (LS) or one with a high solubility (HS). These are used in 6 solubility/particle size combinations consisting of either 100% fine granular, a 16X120 US mesh particle size(FG) or 50% FG + 50% pullet size, a 4X8 US mesh particle size (PS) limestone. Results indicated a significant increase in egg specific gravity (ESG) with the addition of pullet size limestone regardless of the solubility. Hens fed 100% FG with LS had significantly lower ESG than hens fed 100% FG with HS. Egg production (EP) was reduced in hens fed 100% FG with LS when compared to hens fed 50% FG LS plus 50% PS LS. The amount of unsolubilized limestone in the gizzard 24 hours after feed removal was greater in hens fed larger particle size combined with FG from HS limestone, but not with larger particles combined with FG from LS limestone. There were no significant effects on feed consumption (FC) or egg weights (EW). Determining the optimal particle size of a LS limestone was the purpose of the second experiment in which 1024 Hyline W36 hens were fed one of 8 diets. Calcium was supplied at two levels (3.5% and 4.0%) and as either 100% FG or 50% FG plus 50% 10X, 8X12 or 4X8 US mesh size particles. Only the PS limestone was used. Hens fed 8X12 and 4X8 had significantly higher ESG than those fed FG or 10X. There were no significant effects on EP, FC or EW. Solubility is an important factor when comparing FG limestone but had no effect when comparing PS limestones. It was thought that the 10X particle size would be large enough to obtain optimal ESG. The second experiment indicates that it is not.

Key Words: Calcium, Limestone, Particle size, Solubility

Influence of Ca:P ratios and strain on pullet growth and bone parameters. M. H. Fosnaught* and K. E. Anderson, North Carolina State University, Raleigh, NC USA.

Selection of commercial laying hens for earlier sexual maturity has in effect decreased the time available for growth and skeletal development, potentially affecting bone mineralization. Our objective was to evaluate the influence of Ca:P ratios and layer strain on pullet growth and bone mineralization. Chicks were reared in quad-deck cages in an environmentally-controlled house at a density of 310 cm²/pullet for 17 wks. The growing period was divided into 3 phases: 1-6, 7-12, and 13-17 wks. A 2X2 factorial arrangement with 5,824 pullets (28 replicates/treatment) was used to evaluate the effects of both dietary regimen (elevated Ca:P+C and control(C)) and strain (Hy-Line W-36(H) and Babcock 300(B)) on the outcome parameters. Pullets from each strain received diets ad libitum with equal Ca:P ratios (2.14) from 1-6 wks. C pullets received Ca:P ratios of 2.14 and 2.42 from 7-12 and 13-17 wks while C pullets received Ca:P ratios of 3.14 and 4.14 from 7-12 and 13-17 wks. Growth was monitored via biweekly measurements of BW, gain, feed consumption (G), and BW with an estimated Na requirement is 0.15% and Cl requirement is 0.23% for growing chickens.

Key Words: Calcium, Limestone, Particle size, Solubility

Influence of feeding high vanadium levels on laying hen performance. R. D. Miles*, R. B. Bressman, and H. R. Wilson, University of Florida, Gainesville, FL.

A 56-d study was conducted using 32-wk old Single Comb White Leghorn hens to investigate the influence of dietary supplementation of vanadium (V) on performance. Ammonium metavanadate was added to a corn and soybean meal control diet to supply 20, 40, and 60 mg V/kg diet. Feeding V at the two highest levels resulted in a reduction (P < 0.05) in feed intake. Feed conversion was not affected by V supplementation. During the first 28-d period, egg production was less (P < 0.05) for the hens fed 40 and 60 mg V/kg diet compared to those fed the control and 20 mg V/kg diet. In the second 28-d period, egg production of hens fed the 60 mg V/kg diet was also less (P < 0.05) than that observed for those fed the diet containing 40 mg V/kg. Hens fed V supplemented diets had poorer (P < 0.05) egg interior quality (Haugh units, HU) than those fed the control diet. During the 56-d experimental period, HU decreased over time from their initial pre-experimental values for all the V diets, but not for the control diet. By d 54, eggshell weights from the 40 and 60 mg V/kg diet hens were less (P < 0.05) than those from the control and 20 mg V/kg diet hens. A significant (P < 0.05) decline in hatchability of fertile eggs was observed at 60 mg V/kg diet in the first 28-d period and at 40 and 60 mg V/kg diet in the second 28-d period. A dose related decline (P < 0.05) in percentage total hatch was observed during the second 28-d period with the 60 mg V/kg diet level having the greatest (P < 0.05) decline. As the dietary V concentration increased, the percentage of fecal moisture also increased (P < 0.05). Based on the results of this study, dietary concentrations of 20 mg V/kg diet will, over time, cause a decline in egg interior quality, percentage total hatch and an increase in fecal moisture. Feeding the higher dietary concentrations of 40 and 60 mg V/kg diet resulted in increased fecal moisture and decreased feed consumption, egg fertility, hatchability and egg production.

Key Words: Laying Hens, Vanadium, Performance

Sodium and chloride nutritional requirements for growing broiler chickens (21 to 42 days of age). A. E. Murakami, E. O. Oviedo-Rondon*, A. C. Furlan, I. Moreira, and R. F. Vasconcelos, Universidade Estadual de Maringa, Maringa, Parana, Brazil.

Two trials were conducted to determine sodium (Na) and chloride (Cl) requirements, electrolyte balance and its effects on acid-base balance, litter moisture and tibial dyschondroplasia (TD) incidence for broiler chickens at growing period. 1,500 21-day-old Cobb broilers were allotted in a completely randomized design with six treatments, five replicates and 50 birds by experimental unit. Treatments used on both trials were a basal diet with 0.10% of Na (Exp. 1) or Cl (Exp. 2) supplemented with 0.0, 0.05, 0.10, 0.15, 0.20 and 0.25% in litter moisture. The hypertrrophic area of growth plate in the proximal tibiotarsi increased with Cl levels. A non-linear model describes this response. Best electrolyte balance was estimated that Na requirement is 0.15% and Cl requirement is 0.23% for growing chickens.

Key Words: Acid-base balance, Chloride, Requirements, Sodium, Tibial dyschondroplasia

Sodium (Na) and chloride (Cl) nutritional requirements, dietary electrolyte balance and its effects on acid-base balance, litter moisture and tibial dyschondroplasia (TD) incidence for broiler chickens were
evaluated in two trials. 1,500 one-day old Cobb broilers were allotted in a completely randomized design with six treatments, five replicates and 50 birds by experimental unit. Treatments used on both trials were a basal diet with 1.30% of Na (Exp. 1) or Cl (Exp. 2) supplemented with 0.0, 0.05, 0.10, 0.15, 0.20 and 0.25% resulting in diets with Na or Cl levels of 0.10, 0.15, 0.20, 0.25, 0.30 and 0.35% of Na or Cl. At Exp. 1 results indicated an optimum Na requirement of 0.26% (body weight gain), 0.25% (feed intake) and 0.28% (feed conversion). Sodium levels caused a linear increase (P ≤ 0.01) in blood gases parameters (pH, HCO₃⁻, BE). The hyperpneic area of normal (normoventilated) gill tissue was maintained with Na levels. A non linear model describes this response. TD incidence decrease with increases in dietary Na. Litter moisture increased linearly (P ≤ 0.01) with Na levels. At Exp. 2, Cl requirement was estimated in 0.27% (body weight gain), 0.30% (feed intake) and 0.25% (feed conversion). Chloride levels caused an quadratic effect (P ≤ 0.01) on blood gases parameters, with a value near of equilibrium (Base excess < 0) at 0.30% of dietary Cl. It was not observed effect (P ≥ 0.05) of Cl levels in litter moisture or TD incidence. Best electrolyte balance of diet was 298-315 mEq/l at Exp. 1 and 246-264 mEq/kg at Exp. 2. It was determined that Na requirement for young broiler chickens is 0.28% and Cl requirement is 0.25%.

Key Words: Acid-base balance, Chloride, Requirements, Sodium, Tibial dyschondroplasia

281 Effect of citric acid on calcium and phosphorus utilization and requirements for chicks fed phytate-free and corn-soybean meal diets. S. D. Boling¹, C. M. Parsons, and D. H. Baker, University of Illinois, Urbana, IL USA

Data previously reported by our laboratory indicated that supplementation of a corn-soybean meal (SBM) diet with citric acid improves phosphorus (P) utilization in chicks. The three experiments reported herein were conducted 1) to evaluate the effect of citric acid on P utilization in a phytate-free diet and 2) to determine the effects of citric acid on the Ca and available P (AP) requirements of chicks fed a corn-SBM diet. Diets in all experiments were fed to four replicate groups of four chicks from 8 to 22 days of age. The first experiment utilized a phytate-free, casein-dextrose diet to confirm the hypothesis that the previous beneficial responses of citric acid in a corn-SBM diet were due to effects on phytate-P. Treatments included a basal (B) diet (0.5% Ca, 0.15% P), B + 0.10% P, and B + 3 or 6% citric acid. Addition of P resulted in significant (P < 0.05) positive responses in growth and tibia ash, whereas citric acid supplementation had no beneficial effects. The second experiment evaluated the effect of 6% citric acid on the Ca requirement of chicks. A corn-SBM basal diet (0.54% Ca, 0.45% available P) containing 0 to 0.7% supplemental Ca, titrated in 0.1% increments, was fed ± 6% citric acid. Growth performance and tibia ash were increased by Ca supplementation, and the results indicated that citric acid did not significantly affect the Ca requirement. The final study was performed to determine if citric acid would reduce the level of supplemental P required in a corn-SBM diet. Treatments included a basal diet (1.3% Ca, 0.20% AP) with increments between 0 and 0.25% supplemental P ± 6% citric acid. When no citric acid was present, the maximum response in weight gain and tibia ash was observed with 0.20% added P. In diets containing citric acid, weight gain was maximized at 0.05% added P and tibia ash was maximized at 0.10 to 0.15% added P. These results indicated that 6% citric acid was releasing approximately 0.10% available P.

Key Words: Citric acid, Phytate, Phosphorus, Calcium, Chicks

282 Response of Heat-distressed Broilers to Chromium-L-methionine Supplementation. H. E. Brown¹, M. O. Smith¹, and T. M. Fakler²,¹ The University of Tennessee, Knoxville, TN; Zimplo Corporation, Eden Prairie, MN.

Male broilers were used to evaluate the effects of supplemental chromium-L-methionine (CrMet) on plasma insulin, glucagon, serum triglycerides, growth performance and carcass traits of heat-distressed broilers. Test diets supplemented with CrMet at 0, 200, 400 and 800 μg Cr/Kg were fed to chicks raised on floor pens to day 21. Birds were transferred to wire cages in two environmental chambers on day 22. One chamber was maintained at 23.9 C (thermonuclear, TN) while the other cycled between 23.9 and 35 C (heat distress, HD) until day 49. Birds in HD had increased glucagon and triglyceride, but decreased insulin. Within environment, CrMet tended (P < 0.05) in HD, but was unaffected by dietary treatment. Birds in HD had decreased (P < 0.05) breast and increased abdominal fat as a percent of carcass weight, but the weights of market parts as a percent of carcass weight were unaffected by CrMet. Results indicate that heat distress influences growth and carcass composition of male broilers and the effects of CrMet were minimal under these conditions.

Key Words: Chromium-L-methionine, Broilers, Heat-distress